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FORMULA FOR FORCE OF MORTALITY.

Editor Analyst:

An essay of mine on "Methods of Interpolation applicable to the graduation of irregular series, such as tables of mortality, &c.", part of which appeared in the *Smithsonian Report* of 1873, contained among other things, at page 343 of that report, a demonstration of the formula

$$\mu_3 = \frac{8(y_2 - y_4) - (y_1 - y_5)}{12y_3},$$

where y_1, y_2, &c., are the "numbers living" at any five consecutive birthdays, out of a certain number of persons born, and μ_3 is the "force of mortality" at the middle birthday. The same formula has since been published, with a different demonstration and notation, in an article by Mr. W. S. B. Woolhouse, in the London *Journal of the Institute of Actuaries and Assurance Magazine* for April, 1878, page 64. I wrote to the editor in the October following, stating my priority, and asking to have it mentioned in the *Journal.* This request has not been complied with up to July, 1879, the date of the latest number I have seen. The January 1879 number contains, at page 285, a laudatory reference to the formula, and the name of Mr. Woolhouse only is mentioned as its author. I ask leave therefore to put the facts on record, and remark further, that a copy of the *Smithsonian Report* referred to was sent to the editor of the *Journal* in 1875, so that he had no need to be in ignorance—if he was ignorant—of the existence of my work, in April, 1878.

E. L. De Forest.

Watertown, Conn., Jan. 8, 1880.

Correspondence Relative to Problem 286.

Editor Analyst:

Problem 286 was proposd some years ago, in the *Educational Times,* and discussed thoroughly. Mr. Woolhouse made a solution the same as that by Mr. Adcock. Stephen Watson afterward made a solution obtaining the result $\frac{2}{5}$, which Mr. Woolhouse admitted was correct, and I believe was finally so admitted by all. (See *Educational Times* for Jan. 1870, June '70 and Sept. '71. The solution of Prob. 193, Analyst, also solves this.

Walter Siverly.

Oil City, Pa., Dec. 29, 1879.

[Because, in the denominator of the fraction which represents the req'd probability, the points through which the circles are supposed to be drawn are evenly distributed over the area of the given circle, while in the numerator, of the published solution, they are represented by circumferences of circles that intersect oneanother, and therefore cannot be evenly distributed over the given circle; the terms, therefore, of the fraction which represents the required probability in the published solution, are non-homogeneous and hence do not necessarily represent the required result.

Instead of publishing Mr. Seitz's solution, as we promised in No. 1, we refer the reader to the solution of Problem 193 (Vol. V, p. 61), which can easily be modified so as to meet the requirements of this problem.—Ed.]

NOTE ON THE COMPUTATION OF π. By PROF. J. SCHEFFER.—Perhaps the most *convenient* way of calculating π may be derived from the development of $\sin^{-1}x \div \surd(1-x^2)$ into a series. Multiplying the well known series of $\sin^{-1}x$ and $1\div\surd(1-x^2)$ together, the law of the formation of the coefficients of the ascending powers of x would not easily become apparent, but this difficulty will be obviated by the following method.

Putting $(\sin^{-1}x)^2 = Ax^2+Bx^4+Cx^6+Dx^8+Ex^{10}+\ldots \qquad (1)$
and differentiating, we obtain:

$$2\sin^{-1}x\div\surd(1-x^2) = 2Ax+4Bx^3+6Cx^5+8Dx^7+10Ex^9+\ldots \qquad (2)$$

Multiplying (2) by $\surd(1-x^2)$, and again differentiating,

$$2\div\surd(1-x^2) = (2A+3.4Bx^2+5.6Cx^4+7.8Dx^6+9.10Ex^8+\ldots)\surd(1-x^2)$$
$$-(2Ax+4Bx^3+6Cx^5+8Dx^7+10Ex^9+\ldots)x\div\surd(1-x^2).$$

Multiplying this equation by the radical, and comparing the coefficients of the same powers of x, we find for the coefficients the following values:

$$A=1,\ B=\frac{2^2}{3.4},\ C=\frac{4^2}{5.6}B=\frac{2^2.4^2}{3.4.5.6};\ D=\frac{6^2}{7.8}C=\frac{2^2.4^2.6^2}{3.4\ldots8}, \text{ ete.}$$

We may present these coefficients in another form, viz.;

$$A=1,\ B=\frac{2}{3}\cdot\frac{1}{2},\ C=\frac{2.4}{3.5}\cdot\frac{1}{3},\ D=\frac{2.4.6}{3.5.7}\cdot\frac{1}{4},\ E=\frac{2.4.6.8}{3.5.7.9}\cdot\frac{1}{5}, \text{ etc.}$$

Substituting in (2) we get

$$\frac{\sin^{-1}x}{\surd(1-x^2)}=x+\frac{2}{3}x^3+\frac{2.4}{3.5}x^5+\frac{2.4.6}{3.5.7}x^7+\frac{2.4.6.8}{3.5.7\ 9}x^9+\ldots \qquad (3)$$

Put $x=y\div\surd(1+y^2)$, then is $\sin^{-1}x=\sin^{-1}[y\div\surd(1+y^2)]$, and (3) becomes

$$\tan^{-1}y=\frac{y}{1+y^2}\left[1+\frac{2}{3}\left(\frac{y^2}{1+y^2}\right)+\frac{2.4}{3.5}\left(\frac{y^2}{1+y^2}\right)^2+\frac{2.4.6}{3.5.7}\left(\frac{y^2}{1+y^2}\right)^3+\ldots\right].$$

Since $\frac{1}{4}\pi=\tan^{-1}\frac{1}{2}+\tan^{-1}\frac{1}{3}$, we have

$$\frac{\pi}{4}=\frac{4}{10}\left[1+\frac{2}{3}\left(\frac{2}{10}\right)+\frac{2.4}{3.5}\left(\frac{2}{10}\right)^2+\frac{2.4.6}{3.5.7}\left(\frac{2}{10}\right)^3+\ldots\right]$$
$$+\frac{3}{10}\left[1+\frac{2}{3}\left(\frac{1}{10}\right)+\frac{2.4}{3.5}\left(\frac{1}{10}\right)^2+\frac{2.4.6}{3.5.7}\left(\frac{1}{10}\right)^3+\ldots\right].$$